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### **APPENDIX III. INVESTIGATIONS OF ANCIENT CANAL SYSTEMS IN CENTRAL AND EASTERN GEORGIA**

*by Kristen Hopper, Dan Lawrence, Konstantin Pitkhelauri and Graham Philip*

As part of our wider explorations of landscape investment in borderland regions of the Sasanian Empire, our team also investigated several lowland regions of central and eastern Georgia through satellite remote sensing and targeted field visits. Explorations via field survey or remote sensing of other lowland project study regions in the area of Azerbaijan, Dagestan and Iran have revealed that the Sasanian Empire invested heavily in infrastructure related to agricultural production (e.g. canals) and defensive features.<sup>1</sup> Our goal was to determine if similar landscape investments were made in the lowland regions of late antique Iberia. A second aspect of the project has involved the investigation of larger regions beyond the scope of individual surveys, making heavy use of remote sensing data. In Azerbaijan and the Gorgan Plain in Iran, this has proved fruitful in allowing us to see connections and patterns at scales which are rarely examined by archaeologists but were clearly relevant for imperial polities.<sup>2</sup> In Georgia, we can compare and contrast our remote sensing results from the lowland zone with those of our investigations in Khevi to gain insights into the relationship between physical geography, long term histories and imperial interventions.

In contrast to the mountainous Khevi region, the lowland and piedmont plains of Shida Kartli, Kvemo Kartli, Kakheti and the southern portions of Mtskheta-Mtianeti are some of the most agriculturally productive in Georgia (Fig. III:1). Although, Georgia receives on average between 600-1,200mm of rainfall per annum, and water sources are abundant, rainfall varies by region, and in some parts of the arid and semi-arid lowland and piedmont plains irrigation can significantly improve agricultural output.<sup>3</sup>

Small-scale irrigation systems may have been in place to aid in the cultivation of crops such as soft dwarf (nanous) wheat, emmer wheat and naked barley as early as the aeneolithic (Chalcolithic) period in eastern Georgia.<sup>4</sup> A number of studies have also explored the relationship between prehistoric land use and changes in climate and vegetation.<sup>5</sup> Palaeobotanical studies indicate increased human impact on the environment from the mid-Holocene.<sup>6</sup> A rise in agricultural production involving irrigation, linked to growing population centres, has been suggested from the latter half of the second millennium BC,<sup>7</sup> but a significant number of ancient irrigation systems in Georgia have been attributed to the Hellenistic through high medieval periods (Tables III:1 and III:2).<sup>8</sup> Many of these were investigated between the 1930s and the 1960s by Georgian geographers, engineers and archaeologists.<sup>9</sup>

It is these large-scale systems upon which our investigations are focused. We use the term 'large-scale' to describe irrigation systems that are extensive and complex, often watering

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<sup>1</sup> Lawrence & Wilkinson 2017; Payne 2017; Wilkinson *et al.* 2013.

<sup>2</sup> Lawrence & Wilkinson 2017; Hopper 2017b.

<sup>3</sup> Bibikov 1995: 374-75; Gegeshidze 1961: 132-46; Gagoshidze 2008b: 30; K'ik'vidze 1963: 11-12; Nakhutsrishvili 2013.

<sup>4</sup> Chelidze 2006: 73 (English summary); Kohl 1988: 592.

<sup>5</sup> Gogichaishvili 1990; Connor & Sagona 2007.

<sup>6</sup> Gogichaishvili 1990: 268; Connor & Kvavadze 2008.

<sup>7</sup> Tsatskhaldze 2006-2007: 80-81.

<sup>8</sup> Gagoshidze 2008b: 30; Gegeshidze 1961, K'ik'vidze 1963; Losaberidze 1938.

<sup>9</sup> Gegeshidze 1961; K'ik'vidze 1963; Losaberidze 1938.

considerable areas.<sup>10</sup> Evidence for investment in large-scale irrigation systems as part of a dispersal of rural settlements, and the intensification and extensification of agriculture has been recognised in various regions across the Near East and Central Asia throughout the first millennium BC (though in some cases these developments began earlier).<sup>11</sup> In the South Caucasus and North-Eastern Iran, irrigation systems have been explicitly linked to new forms of occupation and concepts of territoriality during the Sasanian period in particular.<sup>12</sup> How far the mechanisms behind these developments are the result of top down impositions by elites, or the products of local social, cultural and political responses to diverse natural environments is a matter of some debate. In some cases, large-scale irrigation systems were the result of planning and implementation by centralised states (and often empires), but there is also evidence for local organisation of complex water management systems; the latter are often more adaptable and sustainable.<sup>13</sup>

This section will bring together the available data on large-scale irrigation systems in central and eastern Georgia and discuss the evidence for the dating of these systems. It will also present new evidence gleaned from the remote sensing of satellite imagery for tracing one of the largest ancient irrigation systems in Georgia, the Alazani Canal. Finally, it will attempt to consider irrigation systems in the context of political developments in the wider region from the mid-first millennium BC.

### ***FROM LOCAL KINGDOMS TO EMPIRES: LARGE-SCALE CANAL SYSTEMS IN IBERIA/KARTLI***

As is clear from Table III:1, large-scale canal systems in Central and Eastern Georgia have been attributed to a wide range of dates (from the second half of the first millennium BC through to the High Middle Ages). These dates are in some cases based on textual sources and in others on associations made between canals and archaeological sites, however, radiometric dating methods have not been employed. In several instances, varied dating proposals exist for individual systems. There are, however, several time periods to which most of the canal building in Georgia is attributed. These are: the Hellenistic period, the fourth-sixth centuries AD and the high medieval period (mid-eleventh-thirteenth centuries AD) (Table III:2).

The Nastagisi, Mukhrani, Telovani, Urbnisi and Tiriponi Canals have all been attributed to the Hellenistic period by various authors (see Tables III:1 and III:2). A reference to the Nastagisi Canal, located near Sarkine, north of Mtskheta the ancient capital of the Kingdom of Kartli<sup>14</sup> can be found in *The Primary History of K'art'li* in the *M'ok'ts'evay k'art'lisay (The Conversion of Kartli)*<sup>15</sup> written some time before the tenth century AD, and likely between the seventh and ninth centuries AD.<sup>16</sup> In this account, the origin of the canal is attributed to a legendary invasion of the region by Alexander the Great.

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<sup>10</sup> For example, the Alazani Canal, which will be discussed in detail later in this chapter, was 119km long and was said to irrigate the entire Alazani Plain, an area according to Gagoshidze (2008b: 30) of 53,000ha.

<sup>11</sup> See Wilkinson 2003: 128-50 for a discussion of this phenomenon; for a selection of examples see Alizadeh & Ur 2007; Altaweel 2008; Braemer *et al.* 2010; Casana 2014; Rousset & Duvet 2001; Wilkinson *et al.* 2005; Wilkinson *et al.* 2013.

<sup>12</sup> Alizadeh 2014; Lawrence & Wilkinson 2017; Payne 2017.

<sup>13</sup> Alizadeh 2014; Hunt 1988; Kaptijn 2010; Mabry 1996; McPhillips 2016; Stride 2009; Wilkinson *et al.* 2012.

<sup>14</sup> The Kingdom of Kartli covered most of what is now central and eastern Georgia. The area was also referred to in western Classical sources as Iberia (e.g. Strabo 11.3).

<sup>15</sup> The entire corpus is named after its main element, *The Conversion of Kartli*, but contains several other historiographical and ecclesiastical texts, one of which is *The Primary History*. See Rapp 2014: 17.

<sup>16</sup> Rapp Jr 2003: 245-46.

‘Then [Alexander] besieged the city of Sarkine for eleven months. And he stopped on the western side of Sarkine and planted a vineyard and drew out a canal [ruy] from the K’sani [River], and he appointed people as canal overseers [meruveni] over the source [?] of the canal [dastagi’a ruysayt’a]; therefore this place is called Nastagisi.’<sup>17</sup>

Alexander never actually invaded the area of modern Georgia, but as Rapp has pointed out ‘his [Alexander’s] vanquishing of the Achaemenid Empire<sup>18</sup> was the chief catalyst for the foundation of K’art’velian kingship at this moment’ and as such this passage has been interpreted as reflecting an attempt to lend authority to the rulers of the newly arisen Kartlian kingdom in the third century BC.<sup>19</sup> Even if the association with Alexander is legendary, it is conceivable that the Nastagisi Canal system was in use by the fourth or third century BC. According to Gagoshidze, it is said to have supplied the third century BC settlement at Nastagisi.<sup>20</sup> Furthermore, according to Gagoshidze, the Mukhrani Canal may also have been in use by this time as the Nastagisi Canal may have been a branch of the Mukhrani Canal. At the very least, the mention of a canal at Nastagisi in the Primary History puts its construction prior to the seventh-ninth century AD.

Several of the canals listed in Tables III:1 and III:2, namely the Rustavi and Telovani Canals, are also suggested to have been built in the last century BC and the first few centuries AD, though the evidence appears to be circumstantial.<sup>21</sup> The Telovani Canal, which has been broadly dated to the Hellenistic/Roman period by K’ik’vidze, is associated with the important Roman-period site of Dzalisi, which it may have supplied, suggesting that the canal was built or at least in use in this period.<sup>22</sup>

Palaeobotanical evidence from excavations of the early first century BC-first century AD palace at Dedoplist Gora in Shida Kartli may also provide evidence for irrigation in this period (though not associated with a specific canal system). Gagoshidze has argued that barley seeds from Room 8 of the palace were found in context with weed types (including *Chenopodium*) associated with moisture and humus rich soil (that is, grown in an irrigated field); furthermore, these grains were considerably larger than populations of the same species from other contexts in the palace.<sup>23</sup>

Perhaps the most extensive ancient canal system in Georgia, the Alazani Canal in Kakheti, has been suggested to have been built between the first and third centuries AD.<sup>24</sup> While the canal itself has not been dated, the account of Iberia as presented by Strabo in the late first century

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<sup>17</sup> Rapp 2014: 177: translation of *Primary History of Kartli*, 6.

<sup>18</sup> The extent of Achaemenid influence (or political authority) in central and eastern Georgia based on the material evidence is still debated (see Knauss 2005; Lordkipanidze 2001; Tsatskheladze 2006-2007). In eastern Georgian, for instance, the main evidence for Achaemenid presence (or at least strong administrative ties) in the region comes from the excavations of an Achaemenid style palace at Gumbati in Kakheti (Furtwängler 1995; Furtwängler & Knauss 1996; 1997.). However, the dating of this complex by the excavators to the fifth -fourth century BC has been contested, with suggestions of both earlier and later dating (Tsatskheladze 2006-2007: 85; Lordkipanidze 2001: 9). Indeed, the relationship between the Achaemenid Empire and its provinces in other parts of the South Caucasus is complex and defining the relationship between the imperial core and satrapies or client kingdoms solely through material culture is fraught with difficulty (Khatchadourian 2014; 2016).

<sup>19</sup> Rapp 2014: 176.

<sup>20</sup> Gagoshidze 2008b: 30.

<sup>21</sup> K’ik’vidze 1963: 89-90.

<sup>22</sup> K’ik’vidze 1963: 81.

<sup>23</sup> Gagoshidze 2008b: 27, 42-43.

<sup>24</sup> K’ik’vidze 1963: 100.

BC or early first century AD may have influenced this dating proposal. While he makes no mention of canals or irrigation, Strabo does describe the agrarian nature of the inhabitants of Iberia and mentioning the fertility of the region supported by its many rivers, including the Alazani.<sup>25</sup> A much later high medieval date for this canal has also been suggested. Losaberidze who investigated the course of the ancient system in the 1930s refers to it as Tamara's Canal, implying an association with Queen Tamara. As Table III:2 indicates, a significant number of canal systems are associated with Tamara, or the high medieval period (i.e. Urnisi, Alazani, Skhaltba-Shiomgvime, Samgori, Akhalsopeli, Gremi and perhaps the Didi Ru). Attributing great building projects to Tamara (as is the case for the Dariali Fort in Khevi, often called Tamara's Fort) is frequent in folk tradition<sup>26</sup> and therefore, while several of these canals may have been built (or even rebuilt) in this period, the association with Tamara should be treated with caution.

Another peak in canal construction appears, according to previous studies, to have occurred in the fourth/fifth-sixth centuries AD (or at least prior to the seventh-tenth centuries AD). The Mukhrani Canal, though potentially originally built in the Hellenistic period, may have been expanded in this period; K'ik'vidze argues that of the three canals that make up this system, the most recent two were likely constructed prior to the eighth century AD.<sup>27</sup> Bibikov argues for the construction of the Mukhrani, Tsilkani, Gaghian (Gachiani), Nakhiduri and the Rustavi Canals between the fourth-sixth centuries AD.<sup>28</sup> Though several of these canals, as already discussed and detailed in Table III:1, may have been constructed earlier, it is possible that they were reconstructed in this period. K'ik'vidze for instance suggests the Rustavi Canal may have been renewed in the fourth century AD (if it was not actually built in this period). Industrial wine production, as evidenced by the presence of kvevri (large ceramic wine vats) in archaeological contexts dated to the fifth-sixth centuries has been cited as evidence for this increase in irrigation and agricultural production.<sup>29</sup>

The context for these developments is of particular interest to our research. From at least the latter half of the third century AD, Iberia (as Kartli is called in the Classical tradition) was a semi-independent kingdom within the Sasanian Empire (though part of *anērān* or non-Iran). There appears to have been, however, considerable Roman influence on the region in the early to mid-fourth century AD.<sup>30</sup> The rise of the Chosroid dynasty under Mirian III and the adoption of Christianity by the Iberian kings in the fourth century signalled the beginning of a period of prosperity and resistance to Sasanian power (often through seeking allegiance with the Roman Empire) which culminated in the rule of King Vakhtang Gorgasali (AD 447-522).<sup>31</sup> After his death in the first quarter of the sixth century AD, Iberia became a province of the Sasanian Empire.<sup>32</sup> Political upheaval appears to have marked the later sixth and early to mid-seventh centuries; attempts were made by the Iberians to re-establish political autonomy in eastern Georgia, the Sasanian and Late Roman empires warred across Transcaucasia, and the region was eventually taken by Muslim armies by the mid-seventh century.<sup>33</sup>

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<sup>25</sup> Strabo 11.3.1-6.

<sup>26</sup> Gagoshidze 2008b: 30. On 'Tamara's Fort', see also chapter 25.7.

<sup>27</sup> K'ik'vidze 1963: 79-80.

<sup>28</sup> Bibikov 1996: 374-75 (citing *Ocherki istorii Gruzii*, vol. 2, Tbilisi 1988: 74 sq.).

<sup>29</sup> Bibikov 1995: 375.

<sup>30</sup> Lang 1983; Lukonin 1983: 729-31; Gignoux 1987/2011.

<sup>31</sup> Lang 1966: 95; Lang 1983. See also chapters 25.2-25.3.2.

<sup>32</sup> Lang 1983: 521. See also chapter 25.3.2.

<sup>33</sup> Lang 1983: 505-36; Minorsky & Bosworth 1986. See also chapters 25.3.2 & 25.4.

Significant investment in canal building has been documented in Azerbaijan and Iran during the Sasanian period,<sup>34</sup> and the same phenomenon has long been recognised in Southern Mesopotamia.<sup>35</sup> In the case of these examples, direct reorganisation of the landscape appears to have occurred, likely by either the state itself or local governors and imperial elites. However, the relationship between the Iberian and Albanian kingdoms (the latter centred on modern Azerbaijan) and the Sasanian Empire differed considerably from that of the regions of Iran and Mesopotamia, forming the core areas of Sasanian control. As a result, very different drivers may have been behind landscape investment, including the role of local kings, community responses to increased economic opportunities afforded by new markets and changes in connectivity and security. Although it is tempting to see the construction of irrigation systems in central Georgia as a purely local phenomenon, the terminology used to discuss the Nastagisi Canal in the *Primary History*<sup>36</sup> (written at least by the ninth/tenth, but possibly as early as the seventh century AD) shows clear linguistic links to Iran. Rapp has recently highlighted these connections in different readings of the passage cited above. While it can be read as referring to the fact that overseers were appointed to look after the head of the canal (*dastagit'a ruysayt'a*), it can also be read to indicate that canal overseers were appointed from the *rudastagi* (the Georgian equivalent of the Middle Persian word *rostag* meaning district, province or river-bed). However, he emphasises that in this case the word appears to have been corrupted suggesting that its original meaning had been forgotten. A third alternative suggests that the passage could also be read to indicate that Alexander 'settled [there] men to keep the *dastagird* of the brook', implying a connection to Middle Persian *dastkirt* meaning a settlement, estate or holding.<sup>37</sup> Some of the administrative terminology in this account therefore shows clear links to the Persian world, perhaps indicating that similar administrative systems survived past Late Antiquity.

Despite the numerous references in textual sources to water management systems, physical remains on the ground have proved elusive. Drawing on the datasets brought together through the Persia and its Neighbours project, we have used historical satellite imagery to trace the remains of as many of the canal systems mentioned in the textual accounts detailed above as possible. We focused our efforts on the Alazani Canal in Kakheti where clear traces of an older canal system were identified alongside the modern canal on the CORONA imagery dating to the 1960s or early 1970s, allowing us to identify locations suitable for field visits and geoarchaeological investigation.

## **REMOTE SENSING OF ANCIENT CANAL SYSTEMS IN GEORGIA – THE ALAZANI CANAL**

The Alazani Plain is bordered on the north and east by the Greater Caucasus Mountains, with the Tsiv-Gombori Range running along its west side (see Fig. III:1). The Alazani River runs the entire length of the plain and forms the border with Azerbaijan to the east and south of Dedoplistskaro, eventually emptying into the Mingaçevir Reservoir on the Mtkvari/Kura River. The Alazani Plain has long been known as one of the most important wine producing regions in Georgia. The majority of the plain is represented by semi-humid lowlands, with an average

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<sup>34</sup> Alizadeh 2011: 2014; Alizadeh & Ur 2007; Lawrence & Wilkinson 2017; Wilkinson *et al.* 2013.

<sup>35</sup> Adams 1981.

<sup>36</sup> The *Primary History of Kartli* which is part of a corpus called *Mok'ts'evay K'art'lisay* (the *Conversion of Kartli*). See Rapp 2014: 170-75.

<sup>37</sup> Rapp 2014: 177-78.

rainfall of 860mm per year. Elm, oak and vine forest thrive.<sup>38</sup> A modern canal, watering a large portion of the plain, takes its water from the Alazani River to the east of Telavi, meeting again with the same river c. 100km further downstream to the east of Dedoplistskaro where it borders the eastern edge of the Shiraki Plain. However, there is evidence for an earlier canal following a similar course.

The old Alazani Canal was investigated by Losaberidze in the 1930s and has been subsequently discussed by K'ik'vidze and Gagoshidze.<sup>39</sup> The length of the canal, according to Losaberidze, was c. 119km. It took its water from the Alazani River near the village of Alvani, eventually debouching back into the Alazani River ESE of Dedoplistskaro. The old canal is c. 20-30km longer than its modern counterpart.

A systematic study of the CORONA imagery obtained for the Alazani Plain revealed a number of possible canal segments located in close proximity to the modern canal (Fig. III:2). On CORONA imagery the remains of ancient canals often appear as dark linear features with lighter margins.<sup>40</sup> The dark middle feature represents the channel, which often retains moisture even in the present day, while the lighter margins represent the upcast from canal construction and subsequent maintenance. The locations of the possible canal sections were also compared to the map and textual descriptions of the old Alazani Canal by Losaberidze<sup>41</sup> as well as to modern high resolution imagery available via the Google Earth platform. In other parts of the Near East, CORONA imagery has proven extremely useful for detecting landscape features that were destroyed by subsequent agricultural and building programmes.<sup>42</sup> In this case, however, modern irrigation schemes appear to predate the images. It is clear that considerable portions of the canal that were visible in the 1930s (as described by Losaberidze), had been attenuated or completely destroyed by the late 1960s. Even fewer segments of the canal were visible on the recent high resolution imagery available through Google Earth, demonstrating the continued impact of agricultural programmes on earlier landscape features.

Combining the evidence available, we classified the possible canal segments to aid interpretation. Those that clearly exhibited the characteristics of canal features, as identified on CORONA imagery from other parts of the Near East and correlated with Losaberidze's descriptions, were classed as 'certain', while those the rest were classed as 'uncertain'. Table III:3 provides information on those sections with the clearest visible traces and their locations are given in Fig. III:2 and illustrated in Figs III:3-6. These areas were targeted for field survey. Two short field visits were made to the Alazani Plain in April and July of 2014 with the purpose of assessing whether any of the segments of the canal identified on the CORONA imagery were still extant and to assess the feasibility of obtaining samples for OSL dating.<sup>43</sup> In April 2014, we visited two locations (A and B) (Figs III:3-4). Unfortunately, identifying and accessing canal traces on the ground proved difficult. The Alazani Plain is a 'landscape of destruction' meaning more recent intensive land use has resulted in earlier features being less likely to survive.<sup>44</sup> The whole area was under cultivation and modern irrigation ditches and field boundaries prevented access to certain areas. Where the location of the canal traces could

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<sup>38</sup> Connor & Kvavadze 2008: fig. 2.

<sup>39</sup> Gagoshidze 2008b: 30; Gegeshidze 1961; K'ik'vidze 1963; Losaberidze 1938.

<sup>40</sup> Altaeeel 2005: 158; Wilkinson 2003: 45-52; Wilkinson *et al.* 2013; Ur 2003.

<sup>41</sup> Losaberidze: 1938.

<sup>42</sup> See Hopper & Omrani Rekavandi forthcoming 2018; Hopper 2017b; Wilkinson *et al.* 2013 for examples from Iran.

<sup>43</sup> The field team consisted of Konstantin Pitskhelauri, Eberhard Sauer, Kristen Hopper and Lisa Snape in April, and Konstantin Pitskhelauri, Dan Lawrence and Kristen Hopper in July.

<sup>44</sup> See Wilkinson 2003: 41 for more detailed discussion of these concepts and further references.

be accessed there was little evidence for them. A further attempt was made in July to locate sections B and C (see Figs III:4-5). No trace of B could be located but, at C we were able to identify a slight linear depression bordered on one side by a slight rise in the ground (Fig. III:7). This may represent the remains of the canal and one of its upcast banks.

That a considerable amount of change occurred over the course of the twentieth century is clearly demonstrable by observing the palimpsest of activity that is visible on the CORONA imagery. Recently, the concept of Historical Landscape Characterisation (HLC), more commonly used in the UK, has been applied to case studies in the Eastern Mediterranean and, even more relevantly, in the South Caucasus to help identify pre-Soviet period landscapes.<sup>45</sup> HLC is a technique which seeks to record not just sites and features, but the entire landscape with reference to the historical developments that have shaped it. HLC seeks to identify coherent patterns in the landscape that represent different temporal phases of activity that can be recognised by their distinct landscape signatures. For example a period characterised by Soviet-style collective farms would leave a very different signature from one dominated by independent peasant landowners living in small hamlets.<sup>46</sup>

Applying these principles to a very limited segment of the Alazani Plain near the village of Velistsikhe can help us to understand how twentieth century, and in particular Soviet period, landscape change has altered the plain, and our reading of the archaeological record. Velistsikhe sits on the left bank of the Chermiskhevi River below where the river emerges from the foothills of the Tsiv-Gombori Range. A system of small fields of variable sizes covers most of the alluvial fan of the river system, extending from Velistsikhe toward the Alazani River (Fig. III:8). While many fields are rectilinear, and on a rough grid, there is enough irregularity to suggest the organic growth of the system, perhaps over several generations. In contrast, immediately north of the alluvial fan, there is a system of very regular, large fields which cut into the early field patterning on the edges of the alluvial fan. That these northerly fields are more recent in date is further attested by their relationship with the remains of the Old Alazani Canal. The canal (located at A on Fig. III:2) is only preserved within the area of the smaller field systems on the alluvial fan, while it has been almost entirely erased within the area of the larger regular fields to the north likely due to the deep ploughing associated with Soviet agricultural projects. Losaberidze's description of the old Alazani Canal's course in this vicinity suggests that alterations to the field systems described above may have occurred between the 1930s and the early 1970s when the CORONA imagery was acquired. He indicates that the canal is well-preserved in the area that is covered by the larger rectilinear field systems on the CORONA imagery. Even more recent alterations to these field systems are clear on the modern imagery for the same area available on Google Earth. The large field systems appear to have been further subdivided, perhaps reflecting a shift away from fields associated with collective farms of the Soviet period to fields again in private ownership.

## ***SUMMARY***

In the Alazani Plain, we can clearly identify parts of an ancient canal system on the historical and modern satellite imagery. This study illustrates the potential for using such data sources in conjunction with historical maps and textual accounts especially in landscapes where significant alterations of the landscape have occurred over the course of the twentieth century.

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<sup>45</sup> See Turner 2006 for an outline of the methodology, Crow & Turner 2009, Turner & Crow 2010 and Wordsworth 2018 for applications of the method in Turkey, Greece and Azerbaijan.

<sup>46</sup> Turner 2006: 387.



Further investigations of this, and other canal systems, should be attempted using approaches, such as HLC that help us to understand how the landscape was shaped by continual use and reuse.

However, dating these systems remains a problem. Often, the construction of one canal can be attributed to multiple periods. Textual, archaeological and anecdotal evidence (if undoubtedly often unreliable) currently suggest that the main periods in which canals were constructed (or reconstructed?) may have been the Hellenistic (possibly through to the Roman) period, the fourth-sixth century AD (or at least prior to the seventh-ninth century AD) and perhaps the reign of Tamara in the high medieval period.

These phases of canal building seem to coincide with periods in which we have evidence for strong government (either local or imperial). It is interesting to note that as in the case of the Alazani Canal and Dariali Fort, these constructions often also are attributed to (perhaps erroneously) powerful individuals such as Queen Tamara.

In other regions of the Sasanian dominion there is some evidence for local elites engaging in the building of irrigation infrastructure, along with the clear state-directed (i.e. imperial) canal building projects such as in the Mughan Steppe or the Gorgan Plain.<sup>47</sup> Understanding why this occurred, where and when it did, is of major importance for understanding the nature of the Sasanian state, whether it was a loose confederation or a centralised empire, which is currently a matter of academic debate.<sup>48</sup>

To understand if, and how, the examples discussed here in Central and Eastern Georgia fit into the broader picture of late antique landscape investment, we need to follow several strands of inquiry. We need to obtain dates for these canal systems, preferably through radiometric means. Because of the limited scope of the reconnaissance conducted in the Alazani Plain, we were unable to undertake any test excavations to obtain samples; furthermore, the preservation of the canal in the sections we investigated was poor or completely destroyed. Further survey and investigations involving coring could prove fruitful. A better understanding of the relationship between local elites (for example, the Iberian kingdom) and the Sasanian imperial core over a geographically wider area will also help; if we aim to widen our spatial investigations to include not just the Alazani Canal, but other irrigation systems throughout the South Caucasus, we may gain a better idea of how much, or how little, these projects were driven by imperial power. If imperial-driven investment was taking place on a wide scale, something that the evidence from the Gorgan Plain, Azerbaijan and Mesopotamia seems to suggest, then canal building programmes may suggest that there was close cooperation between local elites and imperial administration.

Finally, it is worth noting that even in this area, where annual rainfall is considerable (though variable from region to region), irrigation systems are a major landscape feature. In Mesopotamia, the introduction of irrigation systems to dry farming areas by the Assyrian, Sasanian and Islamic empires has been seen as an attempt to provide stable crop yields for taxation,<sup>49</sup> and this could also be important in the Southern Caucasus. Market forces may also have played a role as the connectivity made possible by integration with larger empires incentivised intensive crop production, perhaps for emerging urban centres.

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<sup>47</sup> Alizadeh 2014; Hartnell 2014; Payne 2014: 87-88; Sauer *et al.* 2013; Wilkinson *et al.* 2013.

<sup>48</sup> See Payne 2014 and Sauer *et al.* 2013: 616-19 for further information and sources.

<sup>49</sup> Wilkinson & Rayne 2010.

### *Lowlands in local and imperial context*

This research is a preliminary attempt to understand land use patterns from the late first millennium BC through the Middle Ages in a vastly different environment, and at a much different scale, to our more detailed survey work in Dariali. The results, while representing a work in progress, suggest both similarities and, perhaps more importantly, significant differences in the development of upland and lowland landscapes in relation to imperial infrastructure projects.

The lowlands of Central and Eastern Georgia were agriculturally very productive. Periodic, and in some areas sustained, investment in increasing this productivity through the construction and maintenance of large-scale canal systems occurred between the Hellenistic and medieval periods. The current dating proposals suggest a link between periods of strong local or imperial elites and canal building, a trend not entirely surprising. While further dating is required to confirm these associations, and more detailed studies are needed to understand the wider patterns of settlement that accompanied these investments, they seem to demonstrate that there are closer links between landscape changes and wider political developments in lowland regions.

# Tables and Images

Table III:1: Selected ancient canal systems in central and eastern Georgia.

	Canal	Proposed Dates	Publication	Water source	Length	Comments
Mtskheta-Mtianeti	Nastagisi (Nastakisi)	1) Hellenistic 2) At least earlier than the tenth century AD (and possibly from the seventh-ninth century AD)	1) Gagoshidze 2008b: 30; K'ik'vidze 1963: 64; 2) Moktsevai Kartlisai (see Rapp 2003: 258 for translation and dating of this source)	Ksani River	No information	Aqueducts would have been required to transport the water from the Ksani River to Sarkine (K'ik'vidze 1963: 79)
	Mukhrani	1) Early Hellenistic 2) System consists of three canals. The earliest canal could be Hellenistic. The other two were built before the eighth century AD. 3) Fifth-sixth century AD	1) Gagoshidze 2008b: 30 2) K'ik'vidze 1963: 79-80 3) Bibikov 1996: 374-75 (citing <i>Ocherki istorii Gruzii</i> , vol. 2, Tbilisi 1988: 74 sq.)	Ksani River	No information	The oldest of the three canals, possibly constructed in the Hellenistic period, is called 'saglakhao' (K'ik'vidze 1963: 79-80).
	Tsilkani	1) Sixth century AD 2) Vakhust'i Bagrationi, writing in the eighteenth century, attests that there was a canal near Tsilkani built in the sixth century AD (K'ik'vidze 1963: 117)	1) Bibikov 1996: 374-75 (citing <i>Ocherki istorii Gruzii</i> , vol. 2, Tbilisi 1988: 74 sq.) 2) K'ik'vidze 1963: 111-14	Ksani River or the Tkvivliani River	Only 300-350m of the canal was preserved when it was investigated by K'ik'vidze (1963: 111-14). Total length unknown.	Written sources provide two possibilities for the source of the canal (Ksani or Tkvivliani) according to K'ik'vidze (1963: 111-14). He suggests that it is possible the source changed through time.
	Skhaltba-Shiomgvime	Thirteenth century AD (mentioned in a letter of Anton Tschkondideli - თამარ მეფის სიგელი - which describes the building of the canal	Losaberidze 1938: 194-96	Underground stream/Aquifer	No information	Underground canal; starts at Skhaltba (Gegeshidze 1961: 73)

	Canal	Proposed Dates	Publication	Water source	Length	Comments
	Telovani	Hellenistic/Roman <sup>50</sup>	K'ik'vidze 1963: 80-82	Ksani River (flows into the Narekvavi River)	10km	Goes through Dzalisi an important Roman-period site (K'ik'vidze 1963: 81)
Mtskheta-Mtianeti	Didi Ru	Medieval. K'ik'vidze (1963: 84-85) does not specify when in the medieval period the canal was built, but suggest that it was in a period when the economy of Georgia was well developed, perhaps suggesting the high medieval period (e.g. ninth-thirteenth century AD)	K'ik'vidze 1963: 84-85	Ksani River	15km (includes the canal and an aqueduct of at least 6m height) (K'ik'vidze 1963: 84)	Irrigates villages Qanda, Skhaltba, Tserovani, Gorovani (K'ik'vidze 1963: 84).
	Gachiani <sup>51</sup>	Fifth-sixth century AD	Bibikov 1996: 374-75 (citing <i>Ocherki istorii Gruzii</i> , vol. 2, Tbilisi 1988: 74 sq.)	Mtkvari?	No information	
Shida Kartli	Urbnisi (upper and lower canal)	1) Early Hellenistic 2) Earlier than the seventh century AD, and perhaps as early as the second-third century AD (based on associated archaeological finds and the argument that	1) Gagoshidze 2008b: 30 2) K'ik'vidze 1963: 65-66, 70	Liakhvi River	Upper Urbnisi Canal is c. 23-24km long (K'ik'vidze 1963: 70)	At Urbnisi, there is an upper and lower canal, both of which debouch into to the Mtkvari. As with many building works, the canal gets attributed to the period of 'King Tamar', i.e. Queen Tamara. <sup>52</sup> However,

<sup>50</sup> In the table 'Roman' corresponds to the period concurrent with the Roman period elsewhere; Iberia was not a Roman province.

<sup>51</sup> Bibikov transliterates the name as Gaghian, but he is most likely referring to Gachiani.

<sup>52</sup> Tamar or Tamara, though female, is referred to in Georgia as a king, not a queen. K'ik'vidze (1963: 66-68) indicates that the twelfth century date for this canal comes from an eighteenth-century document called "დასტურლამალი" (Dast'uramali).

	Canal	Proposed Dates	Publication	Water source	Length	Comments
		the settlement could not have existed without it.				most evidence suggests it is earlier.
	Tiriponi	1) Early Hellenistic 2) Antiquity?	1) Gagoshidze 2008b: 30 2) K'ik'vidze 1963: 76-77	Unknown, possibly the Mtkvari River?	No information	
	Igoeti	No date	K'ik'vidze 1963: 75	Lekhura River	No information	At least 7 canals in this area, likely ancient (K'ik'vidze 1963: 75)
Kvemo Kartli	Rustavi	1) First century BC-first century AD, rebuilt in the fourth century AD (the town of Rustavi is mentioned repeatedly in the Kartli Tskhorveba and the Moktsevai Kartlisai) 2) End of fourth century AD	1) K'ik'vidze 1963: 89-90 2) Bibikov 1996: 374-75 (citing <i>Ocherki istorii Gruzii</i> , vol. 2, Tbilisi 1988: 74 sq.)	Mtkvari	16km (entire length of system including c. 18 secondary canals = 136km) (K'ik'vidze 1963: 89-90)	Rustavi means head of the canal (K'ik'vidze 1963: 83)
Kvemo Kartli	Nakhiduri	Fifth-sixth century AD	Bibikov 1996: 374-75 (citing <i>Ocherki istorii Gruzii</i> , vol. 2, Tbilisi 1988: 74 sq.)	No information	No information	No information
Kvemo Kartli	Samgori	Twelfth century	Losaberidze 1938: 221	Iori River	20km?	Losaberidze (1938: 222) speculates that if the new Samgori Canal (constructed in the nineteenth century) was built on the same course as the old. If so, the length could have been c. 20km. However, the old canal is not preserved.
Kakheti	Alazani	1) First-third centuries AD 2) Reign of 'King Tamar', i.e. Queen Tamara (1178/1184-1213)	1) K'ik'vidze 1963: 100; Gagoshidze 2008b: 30 2) Oral folk tradition (Gagoshidze 2008b: 30)	Alazani	119km (Losaberidze 1938)	May have involved aqueducts to cross ravines (Gagoshidze 2008b: 30)

	<b>Canal</b>	<b>Proposed Dates</b>	<b>Publication</b>	<b>Water source</b>	<b>Length</b>	<b>Comments</b>
	Akhalsopeli	High medieval	K'ik'vidze 1963: 130	Head in Aveni Valley	3-4km (K'ik'vidze 1963: 130)	System may have included tunnels (K'ik'vidze 1963: 130)
Kakheti	Gremi	1) Eleventh-twelfth century 2) Fifteenth-sixteenth century	1) Gegeshidze 1961: 66-67; A. Mamulashvili cited in K'ik'vidze 1963 2) K'ik'vidze 1963: 130. He argues that the canal likely dates to the period in which Gremi was capital of Kingdom of Kakheti (fifteenth-sixteenth century AD)	Lopota River (Gegeshidze 1961: 66-67)	15km (Gegeshidze 1961: 66-67)	An aqueduct may have been required to traverse the Tornisi Valley (Gegeshidze 1961: 66-67)

Table III:2: Summary of dating of canals.<sup>53</sup>

Canal	Hellenistic	First century BC- first century AD (and 'Roman')	First-third century AD	Fourth-sixth century AD	Pre seventh- eighth century AD	Pre-tenth century AD	High medieval	Late medieval
Mukhrani								
Tiriponi								
Urbnisi								
Rustavi								
Nakhiduri								
Tsilkani								
Nastagisi								
Gachiani								
Alazani								
Skhaltba-Shiomgvime								
Telovani								
Samgori								
Akhalsopeli								
Gremi								
Didi Ru								

<sup>53</sup> For sources, see Table III:1.

Table III:3: Location and description of traces of the Alazani Canal identified on CORONA imagery.

<b>Location (see Fig. III:2)</b>	<b>Start point (UTM 38N)</b>	<b>End point (UTM 38N)</b>	<b>Description</b>	<b>Comments</b>
A (Fig. III:3)	564557, 4633253	567689, 4628387	Section of old canal approximately 6km in length. At c. 1.3km from the start of the section, there are traces of what may be two parallel canals. These are visible for a further c. 2.3km before the two segments appear to merge. This could represent different phases of the canal.	This section closely matches both the map and textual description of the old Alazani Canal given by Losaberidze 1938. Very difficult to see any traces of this feature on the imagery available on Google Earth from 2011. Some small segments may be represented by heavier vegetation growth.
B (Fig. III:4)	569306, 4622761	574317, 4616394	Four aligned segments of the old Alazani canal totalling c. 8km. Near 571567, 4618912 the old canal is cut and crossed over by the new canal.	This section closely matches both the map and textual description of the old Alazani Canal given by Losaberidze 1938. The interface of the old and new canals is just as described in his text. The course is visible along much of the length as differential vegetation growth and/or field boundaries.
C (Fig. III:5)	1) 583526, 4605798 2) 587632, 4603068	1) 585861, 4605229 2) 589140 4602473	Two segments running roughly parallel to, and on the west side of, the modern Alazani Canal. The northernmost segment is c. 2.5km (though a less clear, but convincing extension of this segment continues 1km further north), while the southernmost is c. 1.7km in length.	These segments appear to match the trajectory and location of the old Alazani Canal as described and illustrated by Losaberidze 1938. The first segment is just visible as a wide darker (than the surrounding vegetation) line on the imagery available on Google Earth from 2012.
D (Fig. III:6)	590607, 4600959	591670, 4600596	A c. 1.2km segment of the old Alazani Canal is visible running roughly parallel to, and on the west side of the new canal. There is a less clear, but possible c. 300m continuation of this segment to the east.	This segment appears to match the trajectory and location of the old Alazani Canal as described and illustrated by Losaberidze 1938.



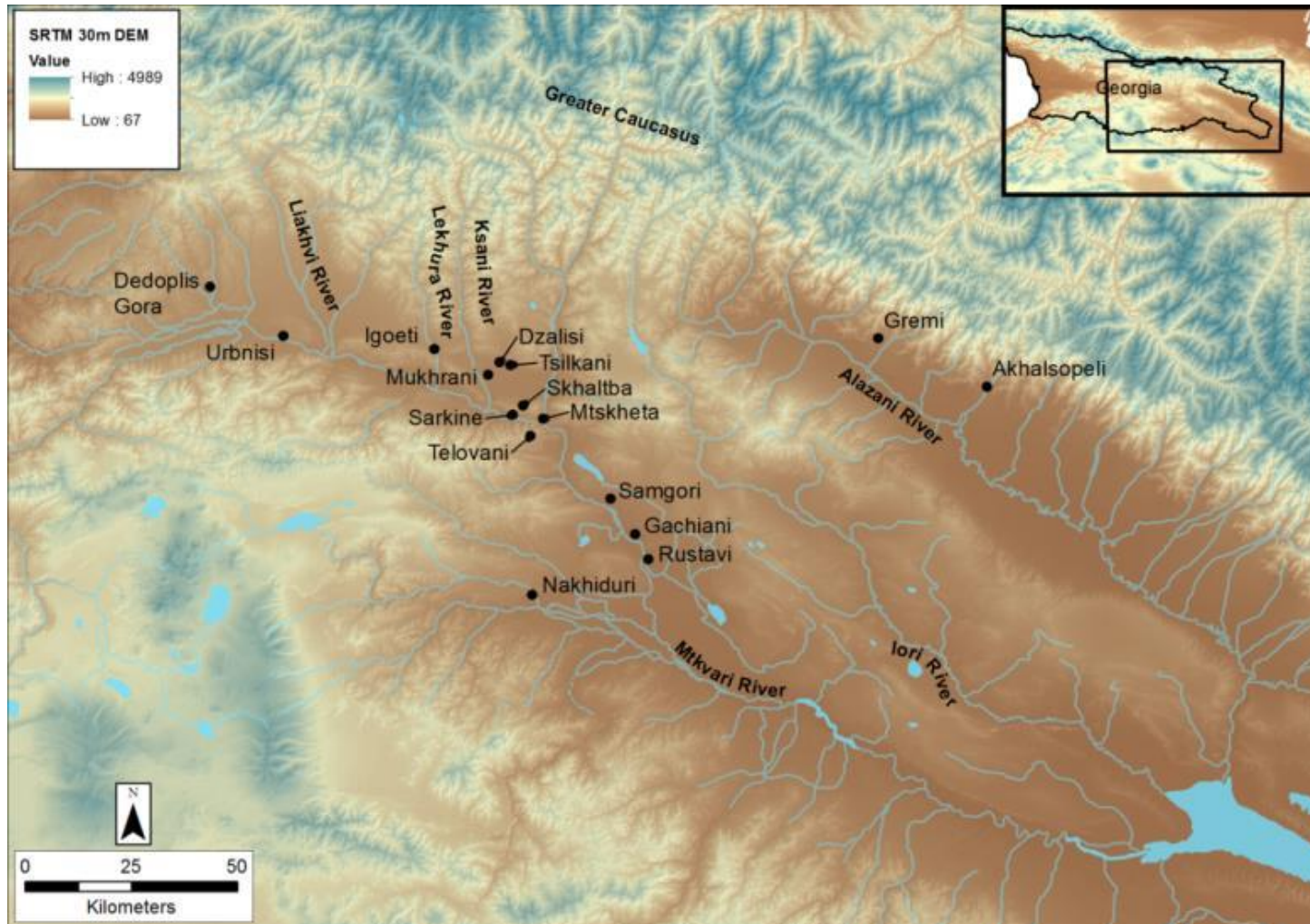


Fig. III:1: Places and geographical features mentioned in the discussion of ancient canal systems. Basemap: SRTM 30m DEM (available from the U.S. Geological Survey).

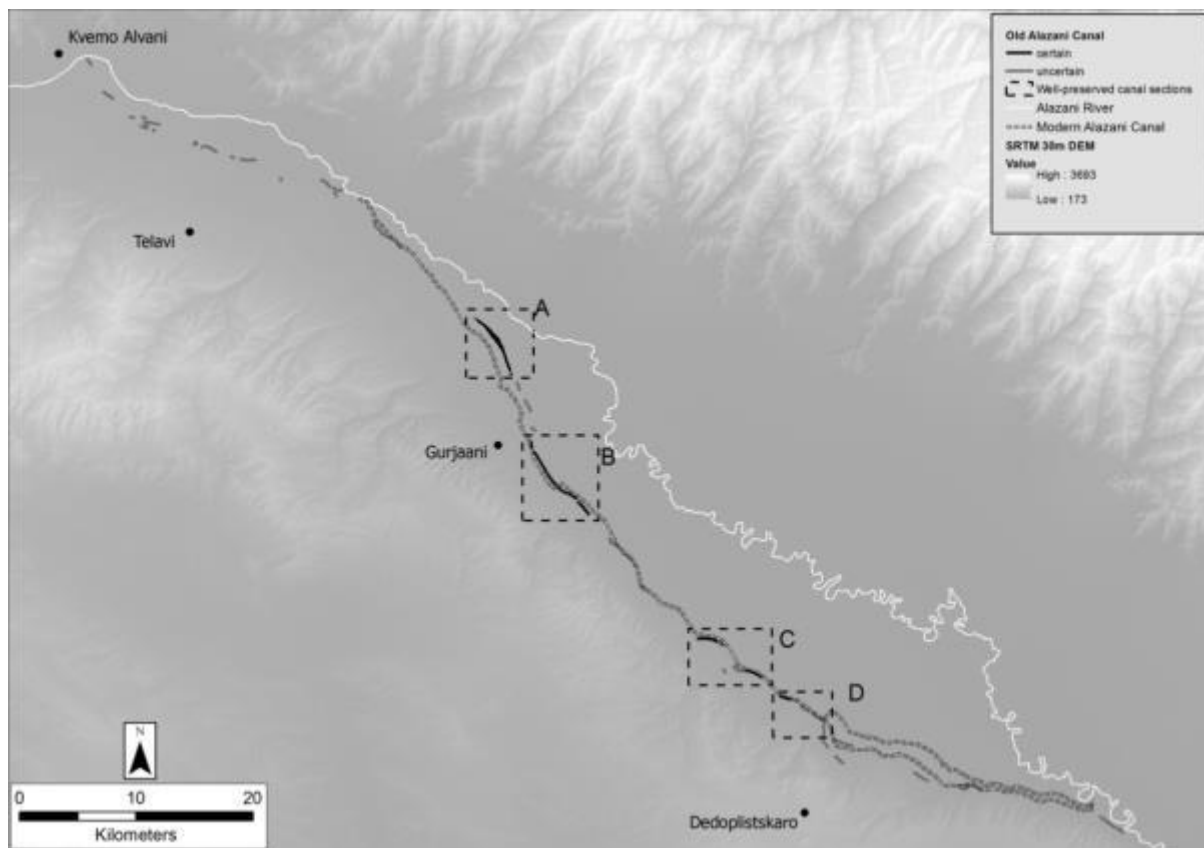


Fig. III:2: Locations of sections of the old Alazani Canal identified on the CORONA imagery. Imagery: SRTM 30m DEM (data available from the U.S. Geological Survey).

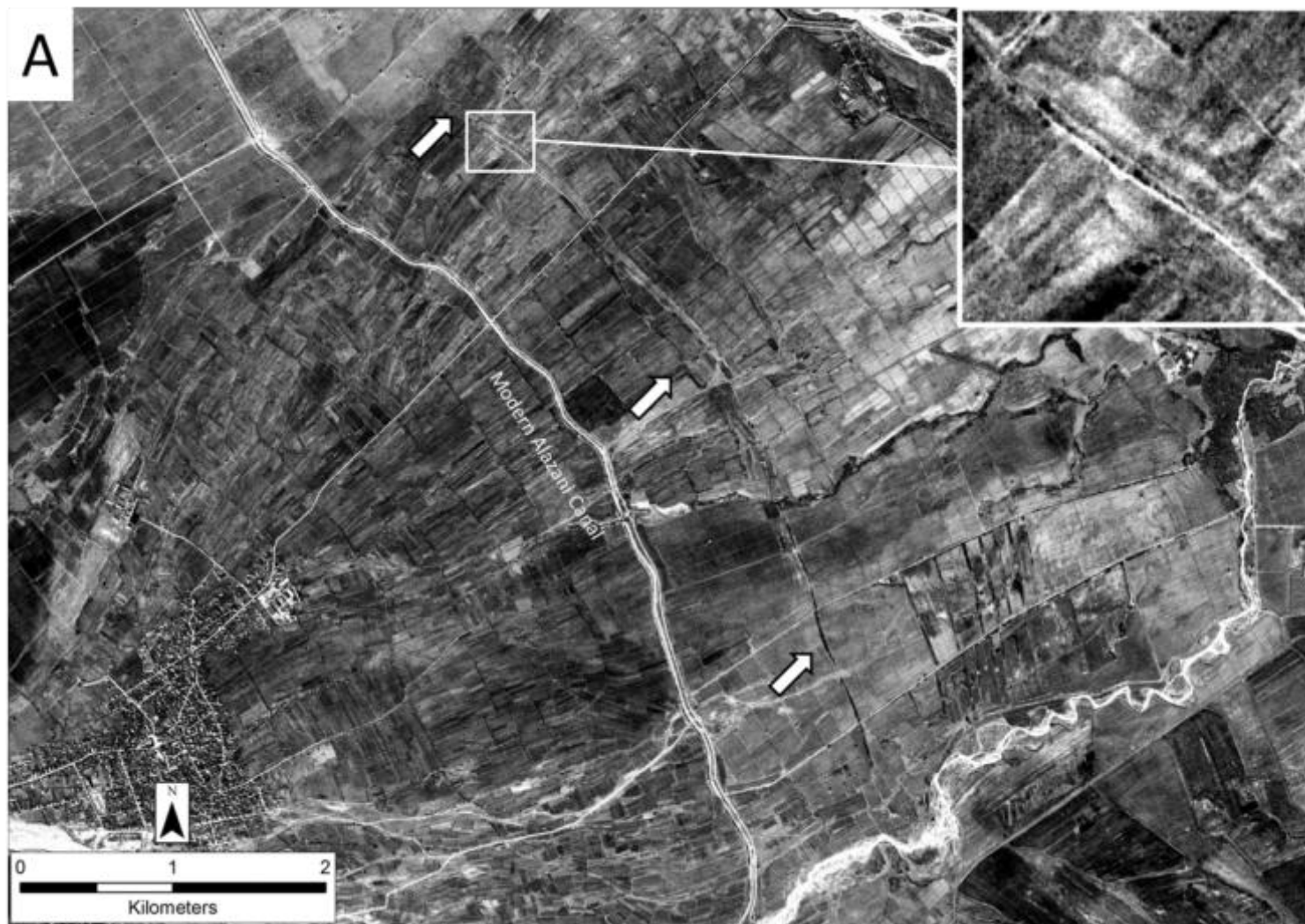


Fig. III:3: Visible segments of the old Alazani Canal. Imagery: CORONA Mission 1046-1056DF020 acquired 18 March 1968 (data available from the U.S. Geological Survey).

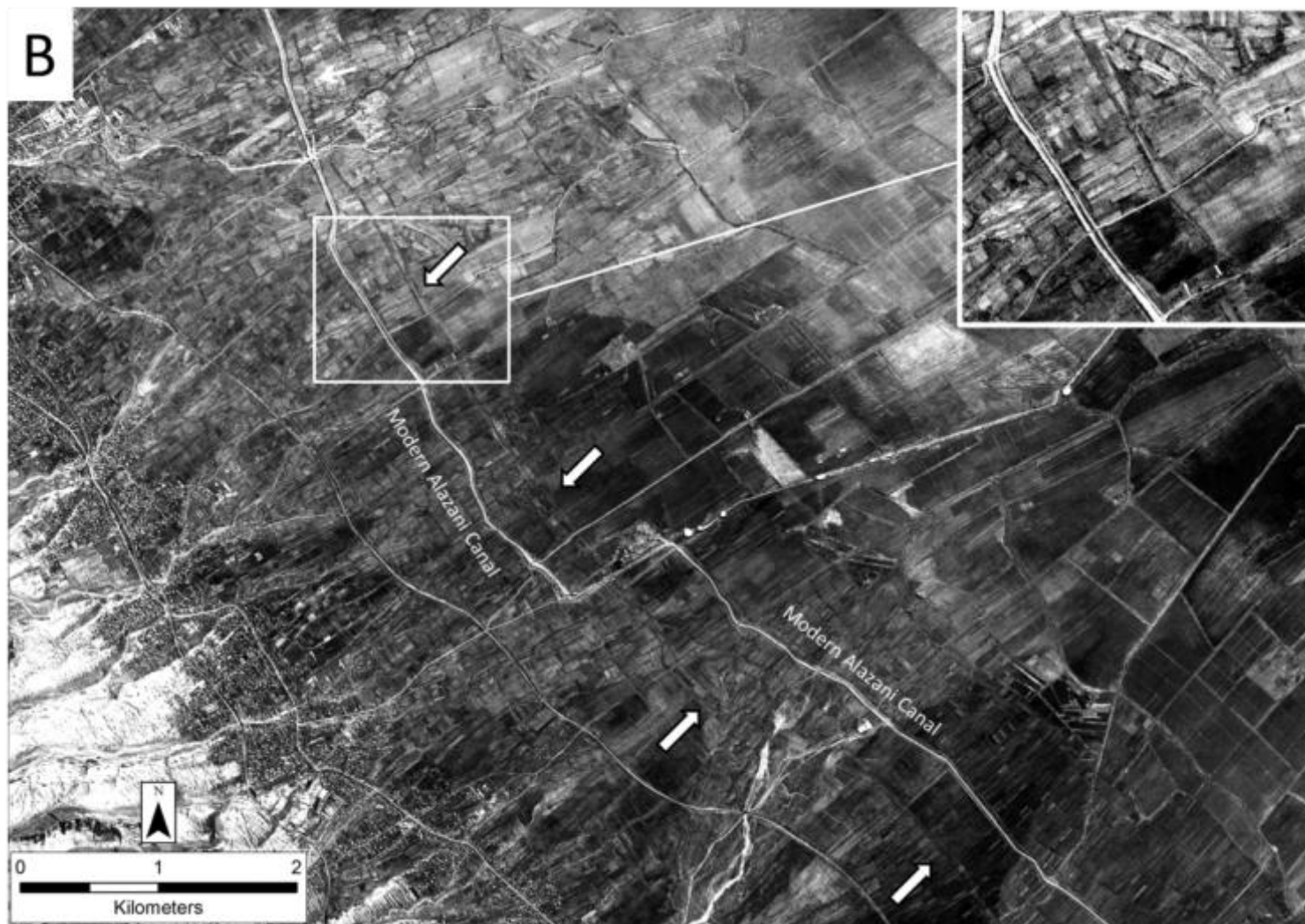


Fig. III:4: Visible segments of the old Alazani Canal. Imagery: CORONA Mission 1046-1056DF021 acquired 18 March 1968 (data available from the U.S. Geological Survey).



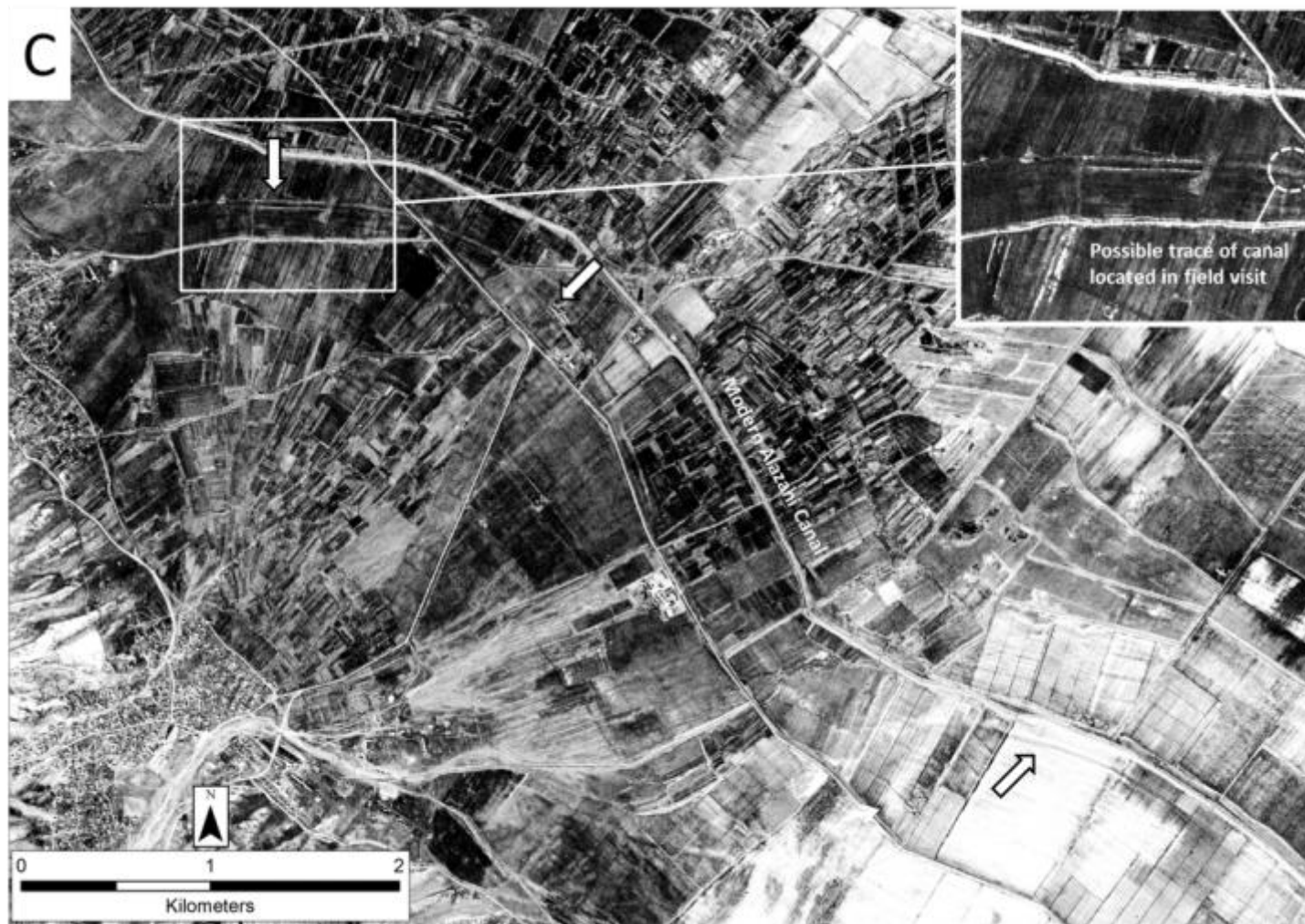


Fig. III:5: Visible segments of the old Alazani Canal. The location of the probably extant segment located during the 2014 field visit is indicated in the inset. Imagery: CORONA Mission 1046-1056DF022 acquired 18 March 1968 (data available from the U.S. Geological Survey).

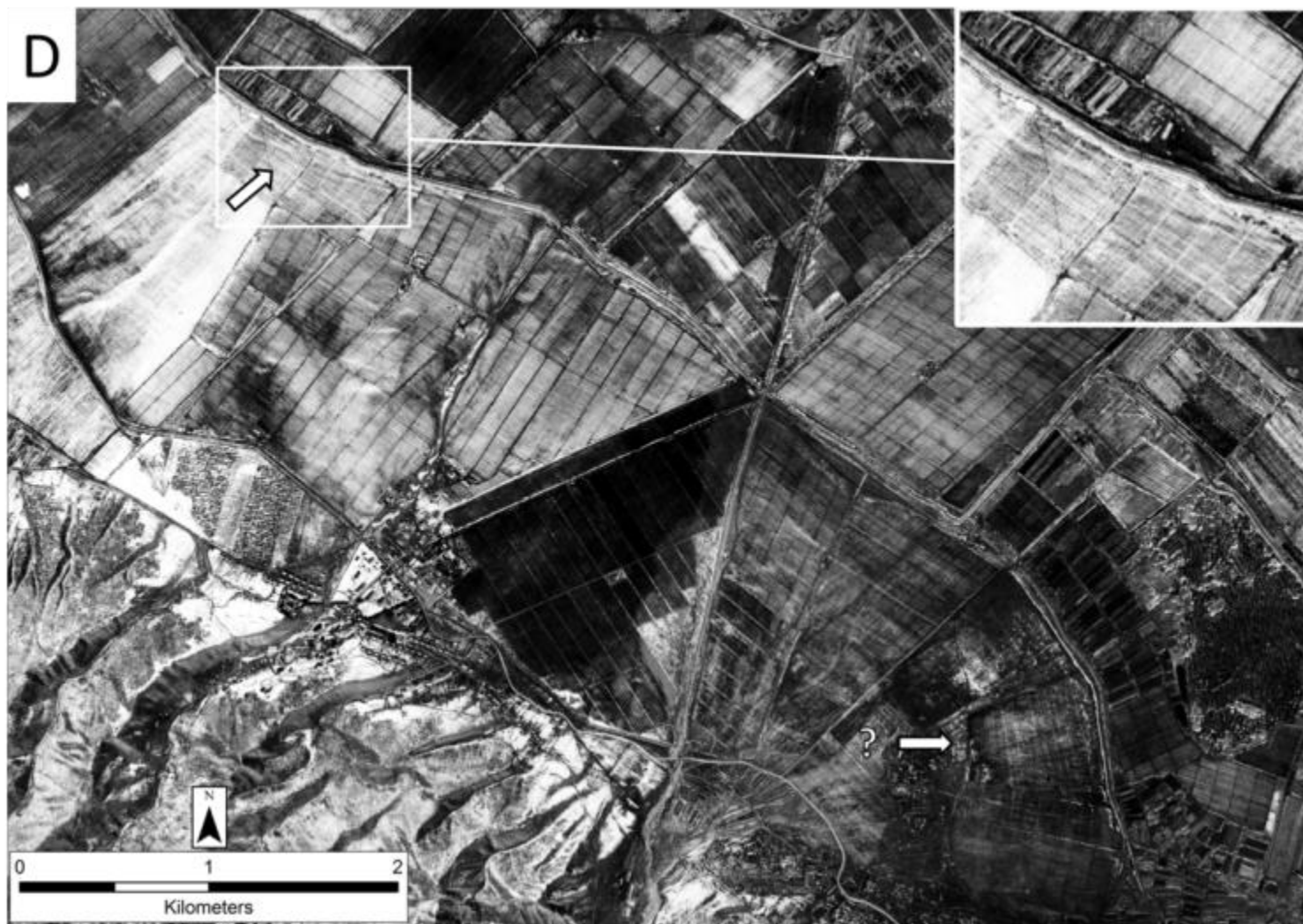


Fig. III:6: Visible segments of the old Alazani Canal . Imagery: CORONA Mission 1046-1056DF022 acquired 18 March 1968 (data available from the U.S. Geological Survey).

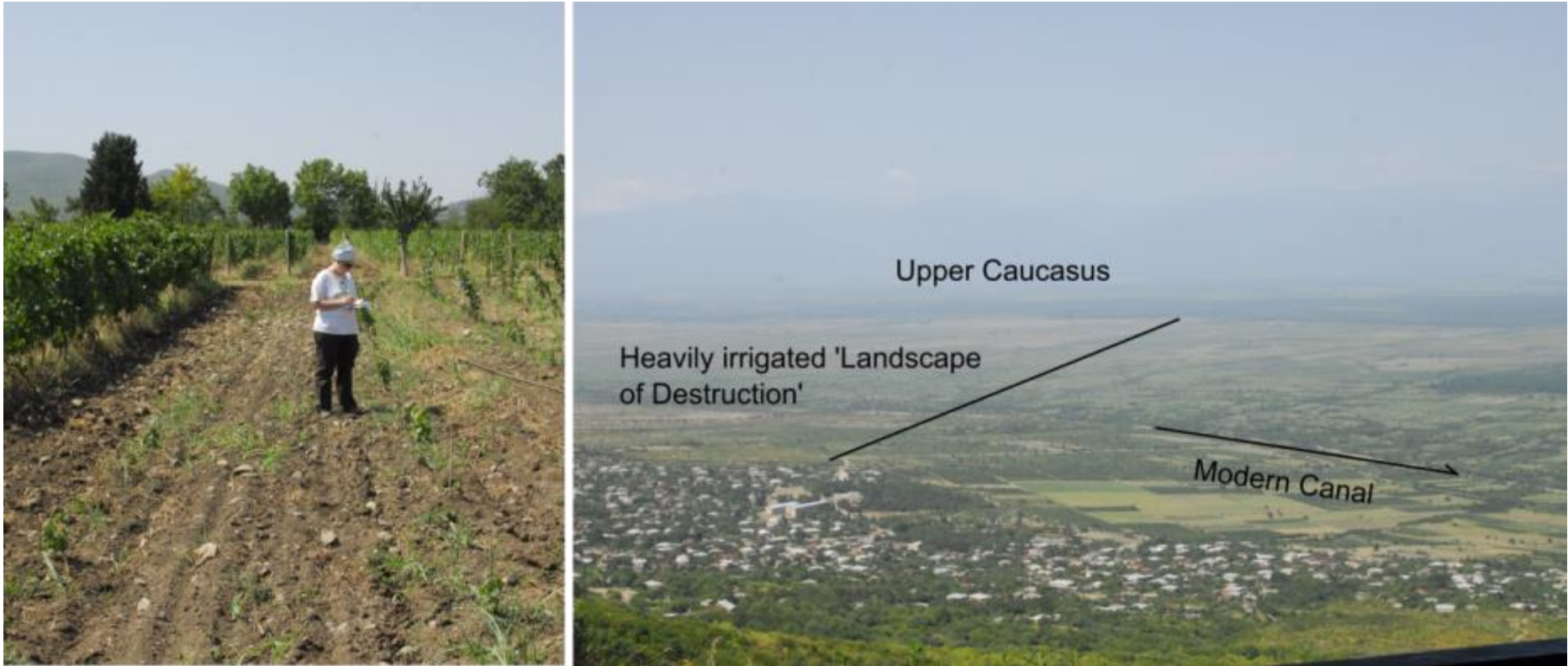


Fig. III:7: Left - Location of the possible canal in the field (see Fig. III:5 for location). Right: the Alazani Plain as a landscape of destruction. Photos by Dan Lawrence.



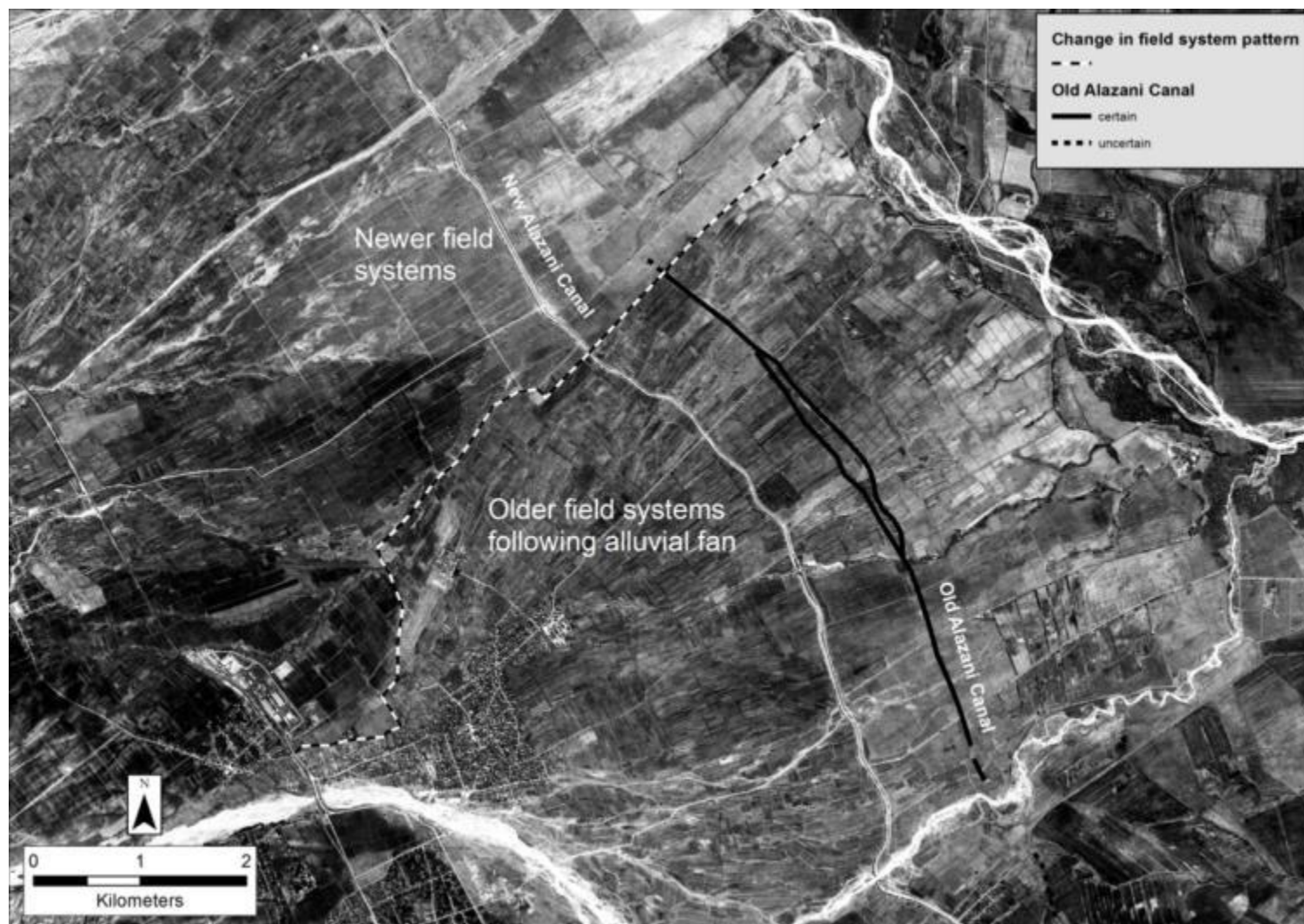


Fig. III:8: Field systems and their relationship with the old Alazani Canal. Imagery: CORONA Mission 1046-1056DF020 acquired 18 March 1968 (data available from the U.S. Geological Survey).